COMPUTER-GENERATED CHINESE PAINTING FOR LANDSCAPES AND PORTRAITS

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ABSTRACT

Practiced for more than three thousand years, Chinese painting stresses the notion of "implicit meaning" in which painters use a minimum amount of strokes to express their deepest feelings. Chinese landscape and figure paintings are the two major themes of Chinese painting. Of relevant interest is more thoroughly understand Chinese art by analyzing basic rules of Chinese painting. This paper proposes two novel methods capable of synthesizing rock textures in Chinese landscape painting and synthesizing portraits in Chinese figure painting, respectively. In addition to saving time during trial and error, these two methods attempt to synthesize painting styles. After users only specify the contour and parameters, our methods underwrite the complete painting process. With the requirement of familiarity with painting skills, individuals can paint various styles of Chinese painting.

Keywords: Non-Photorealistic Rendering(NPR), Chinese landscape painting, TS'UN, Hemp-Fiber Texture Strokes.

1. INTRODUCTION

Computer graphics-related research has focused on obtaining photorealistic images, with particular emphasis on making their syntheses or simulations as realistic as possible. However, for visual effects, photorealism is occasionally not the most effective means of expressing emotions and aroma, accounting for why photographs can not completely replace paintings. Non-photorealistic rendering (NPR) approaches have thus received renewed interest recently. Researchers began to study how to let a photograph or a photorealistic image looked like an art painting.

This paper proposes two methods capable of synthesizing Chinese paintings for landscapes and portraits. Based on rock textures in a Chinese landscape painting, painting models frequently used by painters are developed herein. According to these models and structures, individuals simply define contour of rocks and texture strokes areas sketchily. Our methods then take over the entire painting process. In Chinese portrait painting, our methods include a database of different facial components. This step defines the brush movement and the ink depositing strategy saves them in a components database. Once established with all necessary components, the database allows beginners and experienced users to easily draw.

1.1 Previous work

Depending on the style of painting, NPR research [Hertz98, Litwz97, Masch, Meier96, Salby97, Visyl98] focuses on different aspects. For example, although a proper brush model is vital when simulating a Chinese ink painting, color distribution is the most important aspect of oil painting. NPR research is categorized into three steps. First, photorealistic images are transformed into non-photorealistic images [Hertz98, Litwz97, Meier96, Salby97]. Mapping various user-defined textures or patterns onto an image subsequently generates different styles of the non-photorealistic image. Second, images such as illumination or lighting direction are analyzed to generate various sketches [Masch, Visyl98]. Images generated during this step are normally a monochrome, and a stereo is present via distribution and density of sketching strokes. The third step focuses on the brush and painting model [Curts97, Horac97, Strsm86] in which strokes and ink effects are common, particularly in Oriental paintings. This step is adopted herein since this work generates texture strokes and paint them with a proper brush model.

1.2 Overview

The rest of this paper is organized as follows. Section 2 introduces the property of Chinese painting. Section 3 then describes the policy of hemp-fiber texture strokes. Next, Section 4 summarizes the synthesis of a Chinese portrait painting. Sections 5 and 6 demonstrate the effectiveness of our methods conclusions and areas for future research are finally presented in section 7.

2. CHINESE PAINTING

With a history spanning more than three thousand years, Chinese ink painting heavily stresses the notion of "implicit meanings" by abstracting objects. In addition to separating light and color, this art form avoids depth and other three-dimensional effects such as shadows to preserve the desired features of an object.

Modern Western painting also tends towards abstraction, as evidenced by the confessions of Matisse and Picasso that Chinese paintings influenced their modes of expression. Picasso even experimented with Chinese painting by using brush and ink in more than five albums, each containing forty sheets of paper.

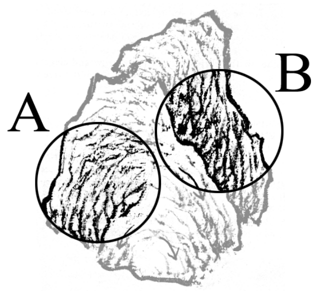


Figure 1. A rock painted with the Hemp-Fiber Stroke.

Chinese landscape painting plays a prominent role in Chinese ink painting. In Chinese landscape painting, rocks are major objects owing to their ability to create the mood of paintings. Artists use the Chinese character TS'UN, also meaning wrinkles, to represent texture strokes applied to rock formations. Over the centuries, masters of Chinese landscape painting developed various TS'UN techniques, which form the basis of an artist's training. Two major types of TS'UN techniques are Hemp-Fiber Strokes (Fig. 1) and Axe-cut Strokes. A slightly sinuous and seemingly broken line, the hemp-fiber stroke is used for describing the gentle slopes of rock formations. Whereas the Axe-cut stroke most accurately depicts hard, rocky surfaces.

Long hemp-fiber strokes express relatively smooth surfaces, while short hemp-fiber strokes provide more wrinkles. Entangled hemp-fiber strokes tend to intercept on another stroke from different directions, expressing roughness of the surface and a feeling of flexibility in the brush application. Developed by the great Southern School master Tung Yuan (907-960 AD), the short hemp-fiber strokes were given variations and generally favored by the literati painters, who dominated mainstream Chinese landscape painting beginning with the emergence of the Four Master of the Yuan Dynasty. The most important of the four Masters, Huang Gung-Wang(1269-1354 AD), practiced the strokes in a loose, calligraphic manner.

Chinese ink figure painting follow the premise of "flavor of painting", the ability to draw a realistic figure or a true-to-life human character. In addition to the lifelike quality of figure painting, how to express a painter's "inner flavor" is of priority concern. Moreover, as characters should be portrayed closely with the sentiment of a painter, a painting moves individuals more easily than a realistic photograph owing to the painter's ability to express his or her feelings and aspirations.

Nevertheless, "flavor of painting" is rather difficult even for a "human" painter to achieve. An ink figure painting can be drawn with true emotions by first analyzing the fuzzy factors of the human mind, which involves psychology and aesthetics. A more concrete definition can be achieved by helping a painter obtain the basic principles of ink figure painting efficiently. Initially, a database of modular components from imitating an existing masterpiece may need to be established. Chang Da-Chien and many other Chinese ink painting masters conferred that imitation is the first step of learning ink figure painting. This should obviously be accompanied by the user's own creativity associated with ink figure components that accurately reflect his or her feelings.

3. CHINESE LANDSCAPE PAINTING

Texture strokes are conventionally applied based on the particular features of painted rocks. Under this circumstance, not many kinds of TS'UN are on a painted rock simultaneously. Only one kind of TS'UN is applied when painting a rock, which is logical since a rock is composed of a single component. Figure 1 illustrates a rock painted only with Hemp-Fiber Stroke. However, texture strokes are varied in different areas of this rock.

Integrating other strokes is relatively easy owing to the effectiveness of the area surrounding the texture strokes. Chinese landscape painting with hemp-fiber strokes is characterized by the following procedure:

(1) An artist begins to visualize a land formation with external contours, which define the overall shape. Internal contour, as added to imply folds on the slopes, reveals the position and direction of the ridge and determines its volume;
(2) After the internal contours are defined, texture strokes are applied in the area;
(3) Hemp-fiber stroke is used to symbolize a smooth land surface; and
(4) Finally, the brush moves along the path of the stroke and deposits ink on the canvas.

3.1 Texture Stroke Area

When rocks are drawn in Chinese landscape painting, the rock contour is normally drawn before applying texture strokes. In contour painting, the painting order of silhouette edges is from the farthest edge to the nearest one because nearer edges may occlude farther edges. Herein, we construct silhouette edges from far to near progressively. According to Fig. 2, the stroke with a higher order (smaller label) implies the farther that it is from relatively view point and is drawn earlier.

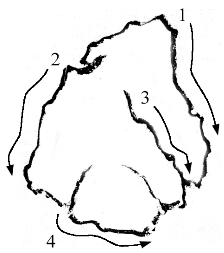


Figure 2. The silhouette edge with higher order (smaller label) is farther to the view point.

The rock contour is constructed by specifying the control points of contour strokes in an orderly manner. Whether some strokes overlap is then determined. When overlapping occurs, the lower-order stroke clips the higher-order one and the higher-order stroke is re-constructed. Figure 3(a),(b) compares the rock contours before and after clipping, while Fig. 3(c) displays the rock contour after applying the Cardinal spline. After the rock contour is constructed, the texture strokes areas are specified. Rock contour specified by user is an important reference when we specify the area surrounding the texture strokes.

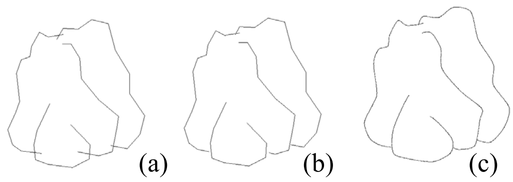


Figure 3. (a) Rock contour before clipping. (b) after clipping. (c)Cardinal spline applied at the cut contour

The area surrounding the texture strokes is a region where only one style of rock textures is applied. In addition, an area surrounding the texture strokes is equipped with a painting mesh, which consists of 10×10 grids, to control the orientation and distribution of texture strokes. According to Fig. 4, although an area surrounding the texture strokes encloses a region, the texture is applied inside the rock contour which is grayish color. Coordinates of each grid point of a painting mesh are mapped to the region where textures are applied. Restated, a painting mesh subdivides the texture strokes painted region into 10×10 sub-regions. This mechanism helps us control the style and distribution of each stroke.

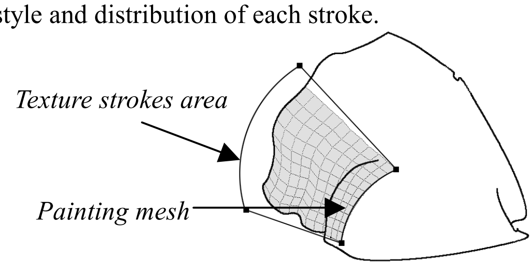


Figure 4. The texture strokes area painting mesh.

3.2 Hemp-Fiber Texture Strokes

In our approach, we parameterize these stroke characteristics and generate various rock textures with different combinations of the parameter values. The knot and exclusive region are used to control the distribution and density of strokes. In this section, we introduce three parameters: length, crossing angles, and perturbation. Stroke styles are presented with the three parameters. With different combinations of spatial and style parameters, users can generate various hemp-fiber texture strokes.

3.2.1 Distribution and Density

In our approach, the distribution and density of strokes are taken as spatial parameters. They present illumination effects, which make the painted rock stereo. Dense strokes are applied to dark rock surfaces and sparse strokes are applied to bright rock surfaces. Moreover, knot and exclusive region are used to control both of them. Consider Figure 5. A knot can generate one or two strokes. If a knot generates two strokes, they cross each other at the knot. Control points are specified at each square overstretched by the strokes in the painting mesh. A set of knots is then placed in the painting mesh, subsequently generating strokes to mold rock textures. Therefore, distribution of knots determines the distribution of strokes. Notably, an exclusive region is involved to control the knot distribution and density.

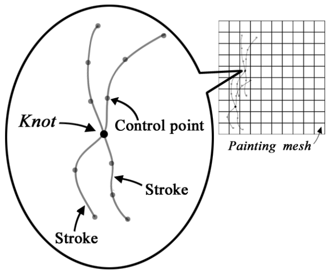


Figure 5. Two strokes generated by a knot

3.2.2 Fiber Length

When hemp-fiber texture strokes are painted, long strokes present a continuous physiognomy of rock, and short strokes make the rocks appear rough and coarse. Since strokes are constrained in the 10×10-grid painting mesh, we limit the stroke length from 1 to 10. Under this mechanism, the length of a stroke refers to how many squares this stroke overstretches in Y direction of a painting mesh. Because we specify "which" square but not "where" to start or terminate a stroke, the actual lengths of strokes are similar, but not the same. Figure 6 shows strokes with different lengths.

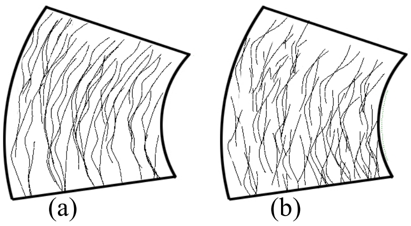


Figure 6. Strokes with average length (a) 8 (b) 5.

3.2.3 Crossing Angle

A knot can generate two strokes, which cross each other at the knot, accounting for why the orientation of strokes can be controlled by crossing angles between these two strokes. In Chinese landscape painting, the orientation and intertwinement of rock strokes are essential. Particularly in Hemp-fiber Stroke, strokes should follow some particular direction and intertwine with each other. Consider Figure 7. Assume that a knot generates two strokes, the primary stroke and the secondary stroke. Where Tp and Ts denote the tangent of the primary stroke and secondary stroke at the knot, respectively. Herein, crossing angles are classified into two categories: α and β. Where α is between Tp and X-axis, and β is between Tp and Ts. When crossed strokes are generated at a knot, orientation of the primary stroke is determined according to α. Similarly, orientation of secondary stroke is determined according to β. Figure 8 shows different values of α and β, resulting in different orientations of strokes. Besides, β is used to control the stroke intertwinement.

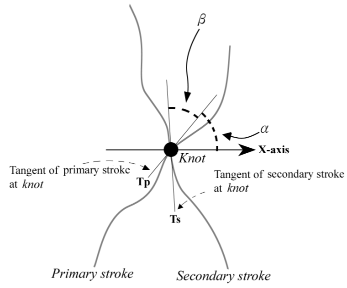


Figure 7. Orientation of strokes generated by a common knot depends on the α and β.

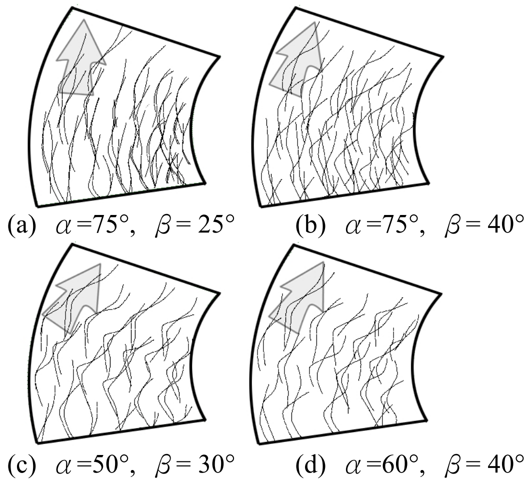


Figure 8. Strokes with different α and βf

3.2.4 Perturbation

Visually, slightly perturbed strokes make rock surfaces appear more undulating. For presenting various rock surfaces, stroke perturbation should be considered an important parameter. Owing to that the strokes are represented in Cardinal spline, the curve can be perturbed by moving the control points. For each stroke, a control point in each row is located, where this stroke overstretches in a painting mesh. These control points can be moved in a proper range. If perturbed strokes are applied, the moving range of each control point is amplified simultaneously. A large moving range implies that control points can not be controlled at a fixed location.

4. CHINESE PORTRAIT PAINTING

The aesthetics of a portrait painting heavily depends on the painter and viewer. Thus, in this study, users are responsible for component figuration and stroke specification. Although this is resembles the imitating step in learning ink portrait painting, traditionally, beginning painters must memorize all figuration and stroke skills and may eventually become masters of ink portrait painting if they can accumulate adequate skills and apply them skillfully. However, effectively and quickly transferring those skills to beginners of ink portrait painting is impossible.

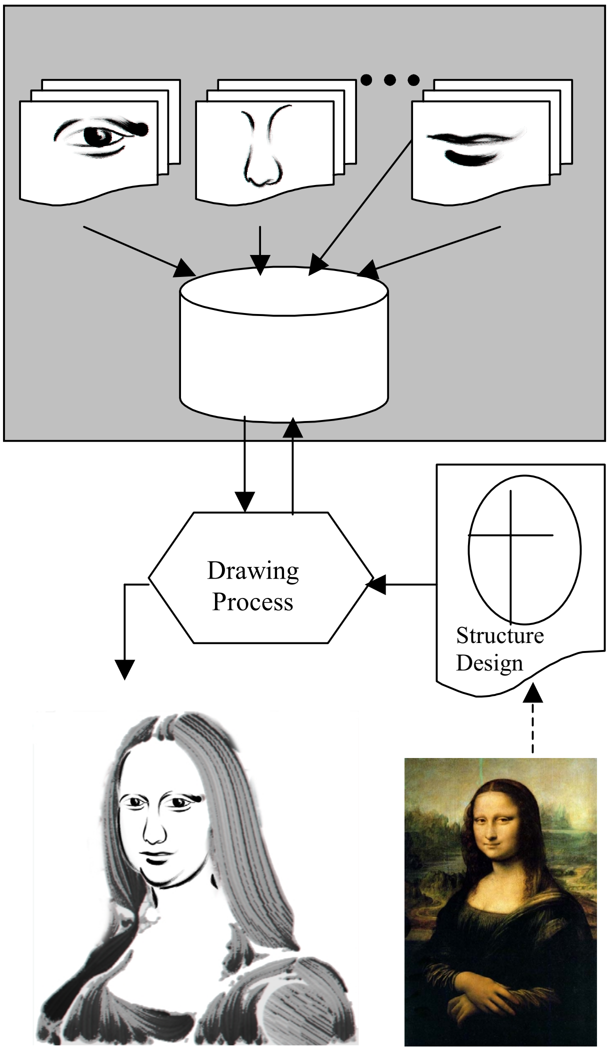


Figure 9. The flow of Chinese portrait painting.

Our methods initially establish a database of different components together with their styles. This step is closely resembles the imitation step of learning traditional ink figure painting. In this step, brush movement and the ink depositing strategy are defined and saved in our components database. This initial process should be done by experienced painters or based on a basic ink figure painting method. Once established with all necessary components, the database allows beginners and experienced users to easily draw. Certainly, the painting quality heavily depends on the components in the database.

The drawing process may take one or two steps. While experienced painters can design the figure structure based on his knowledge of figure painting, beginners may be unable to compose a figure painting. Thus, we provide a reference image to facilitate the structural design. Even beginners can draw a painting with good proportion by orientating the painting structure over the human figure photography or over the portrayal painting.

Figure 9 displays the flowchart of Chinese portrait painting. Our methods provide a database to store all components. Each component contains both figuration and intelligence of stroke skills. Our component definition methodology consists of four steps:

Step 1: Define the component figuration by imitating existing paintings, actual photographs or by user's origination.

Step 2: Specify each stroke with the necessary stroke mechanisms.

Step 3: Define GFPs for this component. GFP is defined to control component deformation, which occurs on primary elements or strokes.

Step 4: Define EFPs for this component if necessary. Despite controlling the deformation, EFP is for optional and expressional purposes. The next section describes Steps 3and 4 in detail.

4.1 Facial Features Components

Feature points are assigned to components in order to offer intuitively refinement control to a component. These feature points are explained as follows:

1. Geometry Feature Point (GFP): Record the feature position and orientation of an element to control object deformation. The number of geometrical feature points is fixed in an element and is different between elements due to the element characteristics.
2. Expression Feature Point (EFP): Record an extra feature position and orientation for expression and style variation purposes. Notably, these feature pints are "optional."

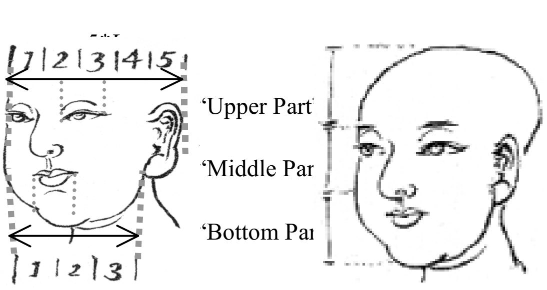
Feature points differ from stroke control ones in that the former manipulates the component-level or at least element-level expression while the latter describes the detailed relative shape and ink distribution of a stroke. Although, they may overlap in the 2D coordinate, feature points and stroke control points conceptually differ from each other.

The first and most important step of ink portrait painting is to “paint the face”. Owing to that success or failure of facial painting largely determines the whole “flavor of a painting”, synthesis of ink portrait painting should begin with facial painting. Chang Da-Chien contended that facial features should be painted in the order of nose, eyes, lips, face outline, ears, and hair. Herein, we introduce each facial component with its primary elements, geometrical feature points, and expression feature points. For other components, which are of great diversity, this paper provides a general methodology to define a novel case component.

The MPEG-4 facial models configuration is adopted herein to design our facial feature components. MPEG-4 facial model is used mainly for standard facial animation and coding methodology and, thus, may be inappropriate for our painting requirements. Herein, two feature points are designed to direct the component painting. The following sections explain the general feature points of facial components in detail.

4.2 Automatic Face Composition

Wang Yi also induced a general face proportion, as illustrated in Fig. 10. In human face proportion, the face width (including ears) is approximately five times wider than eye length, and the cheek width is around three times wider than lips, as shown in (a). A face can be divided into three parts from top to bottom: “upper part”, “middle part”, and “bottom part”. Upper part extends from the hairline to glabella, the middle part is from the glabella to nose tip, while the bottom part extends from the nose tip to chin.



(a) (b)

Figure.10 Face proportion induced by Wang Yi.

Western portrait sketching often uses assistant cross lines for helping painters. Vertical assistant line V extends from the hairline to the chin, which helps remind the painter of face length and position of the nose and mouth. Horizontal assistant line H extends from the left side of the face, through both eyes, to the right side. H reminds the painter of the width of the face and the position of eyes.

This work combines both the Chinese face proportion and the Western assistant cross lines to conduct automatic face composition. The composition process comprises of the following steps:

(a) Draws assistant cross lines to determine the facing direction;
(b) Compute the component proportions;
(c) Determine the lip length;
(d) Refine the facial shape according to the lips length l. Expand or contract the cheek width=3*l; and
(e) Refine the component geometry according to scenography.

4.3 Interactive Refinements

After the automatic drawing process, the user is allowed to conduct three refinements: geometrical refinement, expression refinement and universal refinement. Geometrical refinement is controlled by the GFPs that are assigned to the component. Every GFP has its impact range, i.e., the control points that it can control. The facial expression is mainly controlled by eye component and lip component. Hence, more EFPs are assigned herein to these two components. However, some expressions require both EFP control and GFP control.

In ink figure painting, the universal stroke styles are as critical as the rock texture, referred to as TS’UN, of ink landscape painting. Ink figure painting has 18 conventional stroke styles.

5. CHINESE LANDSCAPE RESULTS

Figure 11 illustrates the area surrounding the texture strokes and corresponding painting meshes of a rock, which is applied to different stroke styles in Fig. 12. Table 1 lists the brush parameters of Figs. 11 (a) and (b). Our methods may imitate the actual scene into Chinese landscape painting. Figure 13(a) displays photographs of Hua Mountain, which is a famous mountain in China. Figure 13(b) illustrates corresponding ink paintings that are generated. Mountains in real paintings normally consist of various styles of texture strokes. Figure 14 shows a picture painted of Huang Gung-Wang. Herein, Figure 14 is counter drawn with various styles of Hemp-Fiber Stroke. Figure 15 summarizes those results.

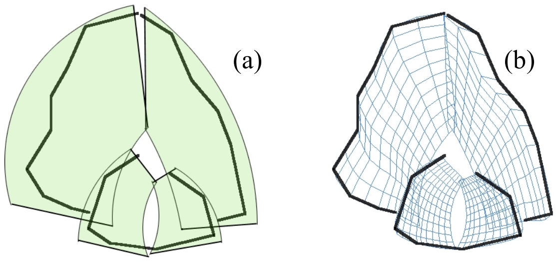
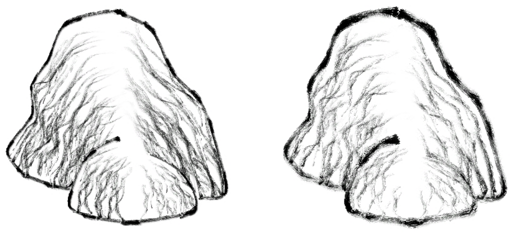


Figure 11. (a) Texture strokes areas and (b) corresponding *painting meshes* of a rock.

Table.1 Stroke parameters of Figure

Figure	Contour stroke size	Texture stroke size	Minimum brush pressure
12 (a)	5.0	4.0	0.4
12 (b)	10.0	6.0	0.2



(a) (b)

Figure 12. Resulting images of Figure 11.

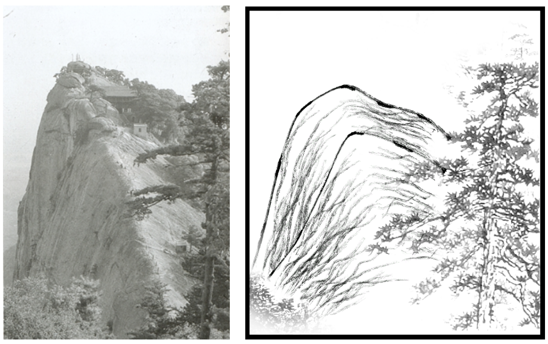


Figure 13. (a)A scene of Hua Mountain .
(b)The Chinese painting of Hua Mountain.
(ps:Trees are synthesized by the post process.)

Figure 14. The original painting by Huang Gung-Wang.

Figure 15. The image counterdrawn from Figure 14. (Trees are synthesized by post process.)

6. CHINESE PORTRAIT RESULTS

Figure 16 presents an imitations of Leonardo Da Vinci's “Mona Lisa”, while Fig. 17 illustrates an imitation of Chang Da-Chien's “Beauty in front of the lily paravent”. Our methods is appropriate for animation production of ink painting. Providing good frame coherence to painting process, It is efficient and flexible means of producing continuous frames while the component database is well established.

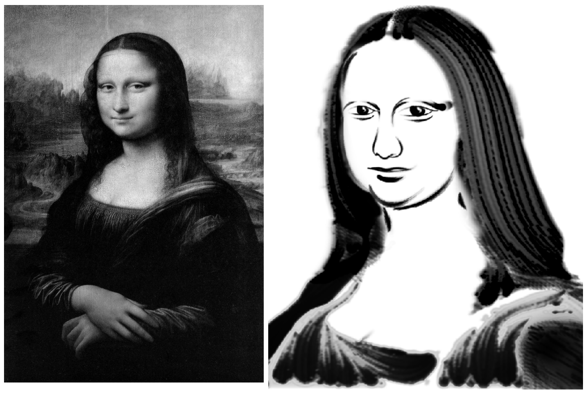


Figure 16. Imitate Leonardo, “Mona Lisa”.

7. CONCLUSIONS AND FUTURE WORKS

This paper presents two methods, one synthesizing rock textures in Chinese landscape painting and another synthesizing portraits in Chinese figure painting. This work saves time spent in trial and error as well as synthesizes painting styles. Users simply specify the contour and parameters, then, our methods underwrites the entire painting process. For example, user can synthesize a Chinese painting based on a reference image or figure. By allowing users to reuse all conventional strokes, we can save the tedium and time consumed by real ink painting, and also make the creation with more and more possibility. Individuals do not need to be familiar with painting skills, and they can achieve various styles of Chinese painting.

Our approach not only saving time in trial and error, but also generates various styles of rocks in short time.

Future studies should address the following issues to enhance our methods.

(1). Our brush model does not emphasize turning effects of brushwork. However, skills in Chinese ink painting are derived from Chinese Calligraphy in many aspects. Our brush model can be improved to synthesize more realistic stroke effects in Chinese painting.

(2). Our paper focuses on using the Hemp-Fiber Stroke. Although it is the major stroke in Chinese landscape painting, many other strokes should be integrated together. Integrating other strokes would not be too difficult since the concept of texture strokes area is highly effective.

(3) Our paper can also be integrated with other rendering and animation systems to generate more impressive rendering results.

Figure 17. Imitate Chang Da-Chien “Beauty in font of the lily paravent”

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